The brain, due to a high degree of oxygen utilization, a high level of unsaturated fatty acids and transition metals (e.g. iron), as well as relatively weak mechanisms of antioxidant defense, is particularly susceptible to oxidative damage (Reiter, 1995). The excessive accumulation of reactive oxygen species and lipid peroxidation products in the brain, which are constantly produced in vivo, may be responsible for the pathogenesis of neurological disorders, such as strokes and neurodegenerative diseases (dementia, Alzheimer's and Parkinson's) (Halliwell, 1992). Therefore, anthocyanins having antioxidant properties may protect the neurons from damage arising during uncontrolled oxidation. In other words, anthocyanins may play a preventive role against neurodegenerative diseases caused by oxidative stress (Bate et al. 2004), provided that these ingredients occur in the environment of nerve cells. However, to reach the brain cells, all compounds present in the blood, including anthocyanins and their metabolites, must first pass through the brain barrier, i.e. blood-brain barrier or the blood-CSF barrier. The purpose of these barriers is to ensure the stability of the environment of neurons present in the central nervous system. They are responsible for the protection against toxic substances and the effects of sudden changes in the blood levels of different substances (e.g. hormones or xenobiotics).

Chokeberry and red cabbage constitute one of the richest sources of anthocyanins amongst the food products in Poland. As indicated in the previous studies, cyanidin (3,3’,4’,5,7 - pentahydroxyflavylium cation), mainly present in glycoside forms, is the base chemical structure of anthocyanin found in chokeberry and red cabbage. The cyanidin-3-galactoside which covering almost 70% of the total content of anthocyanins in chokeberry, is a predominant cyanidin derivative analyzed in this berry (Wiczkowski et al. 2010), with cyanidin-3-diglucoside-5-glucoside being the main structure of anthocyanins found in red cabbage. The glucoside residues of this compound were nonacylated, monoacylated and diacylated with sinapic, ferulic, caffeic and p-coumaric acids. The nonacylated form of cyanidin-3-diglucoside-5-glucoside covers more than 15% of the total content of anthocyanins present in fresh red cabbage (Wiczkowski et al. 2014, 2016).

The previous studies indicated that anthocyanins are absorbed by both the organism of an animal and a human, being present in physiological fluids in the native forms and as conjugates (Fernandes et al. 2014). Our previous study with the volunteers showed that anthocyanins from chokeberry and red cabbage are absorbed and remain in the systemic circulation even 24 h after the intake of both plants. Moreover, cyanidin-3-galactoside and cyanidin-3-diglucoside-5-glucoside are the main compounds from the group of anthocyanins found in volunteers’ blood plasma and urine (Wiczkowski et al. 2010, 2016). In addition, the study of Vitaglione et al. (2007) indicated that upon the intake of anthocyanins, when native anthocyanins and their methylated, glucuronided and sulfated forms appear in the human organism, as a result of biotransformation processes, protocatechuic acid (3,4-dihydroxybenzoic acid) is also formed.

It is not known whether anthocyanins and their metabolites, present in the physiological fluids after consumption of foods rich in these natural pigments, are able to permeate the brain barriers and achieve, at the potential place of impact, a sufficient level to play a protective role towards the nerve cells. Given the above, the aim of the project is to determine the ability of anthocyanins of chokeberry and red cabbage and their metabolites to permeation through the blood-cerebrospinal fluid barrier. The study of a permeation of anthocyanins through the blood-cerebrospinal fluid barrier will be conducted using the in vivo model of ewes (Wiczkowski et al. 2015) and the in vitro model.

The results of this project will clarify whether anthocyanins and their metabolites cross the blood-CSF barrier to find themselves in the environment of neurons and demonstrate the positive effects of these compounds, shown in the previous studies (Min et al. 2011). The project in focus will help to determine the actual level of cyanidin derivatives and /or their metabolites in the sheep CSF after administration of the preparations rich in cyanidin 3-galactoside, cyanidin-3-diglukozyd-5-glucoside, and protocatechuic acid. This study will significantly contribute to the development of the fields of biology, metabolomics, food chemistry and medicine with a special emphasis put on the research into the prevention of neurodegenerative diseases through a proper diet.

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